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Temperature Analysis for Indoor Environmental Quality (IEQ) of UKM Architecture Studio

A.R. Musa[a], N.A.G. Abdullah[a], A.I. Che-Ani[a,b,*], N.M. Tawil[a,b], M.M. Tahir[a]

[a]*Department of Architecture, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia*
[b]*Centre for Engineering Education Research, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia*

Abstract

Indoor environmental quality (IEQ) plays an important role in ensuring the conducive studio-based learning environment for architecture students. This paper looks into one of the IEQ parameter namely temperature condition in an architecture studio. Being centralized air-conditioning at all times, the temperature range is very much important throughout the day since the students are learning, discussing and relaxing in the studio. The methodology adopted is two-fold. First by measuring the temperature using the equipment named LM-8100, and second by questionnaire survey in gauging the temperature comfort and humidity level from students' perspective. Temperature reading is taken for 11-hours in 2 days. The IEQ matrix is developed to analyze these 2 parameters concurrently, that also useful to conclude this study. The finding shows that the temperature setting is not within the range of MS 1525:2007. But interestingly, the students perceived it as normal and do not hinder them to stay longer inside their studio. This is somehow good to the learning environment for short term, but in the long run might give negative health effect to the students.

Keywords: Indoor Environmental Quality; temperature; survey; architecture; studio environment

1. Introduction

Thermal comfort is one of the important aspects in achieving the indoor environmental quality and should be given considerable attention by architects and designers. The indoor temperature affects several human responses, including thermal comfort, perceived air quality, sick building syndrome symptoms and performance at work (Seppänen, 2006).

Indoor environment is important for learning environment because its affects indoor physical environment, subsequently health and quality of life of student (Fisk, 2000). The ideal thermal condition in learning environment has an effect on the mental efficiency of student in situations where students were performing clerical tasks calling for quick recognition and response (Peccolo, 1962). In relation to mental efficiency and thermal conditions, (Canter, 1976) found that human beings work most efficiently at psychomotor tasks when the environment is at a

* Corresponding author. Tel.: +6-03-8921-6299; fax: +6-03-8921-6841.
E-mail address: adiirfan@gmail.com.

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comfortable temperature. Temperature is also implicated in studies of sick building syndrome. Maintaining temperature at the low end of the comfort zone tend to reduce Sick Building Syndrome's symptoms. Similarly, individuals perceive the quality of indoor air to be better when temperature and/or humidity are toward the low end rather than the high end of the comfort zone (Fang et al. 1998). There is also good evidence that moderate changes in room temperature, even within the comfort zone, affect children's abilities to perform mental tasks requiring concentration, such as addition, multiplication, and sentence comprehension (Wyon, 1999).

For architecture students studio based-learning is a place for most students to spend time not only purposely for study and doing their work but also a place for discussion and relaxing (Osman et al. 2009). Therefore, it is beneficial to identify temperature comfort level of internal studio environment in ensuring the conducive studio-based learning environment for architecture student.

2. Materials and Method

The study was performed by using two methods, first by measuring the temperature of the internal environment of the year 3 UKM architecture studio, and the second by given questionnaire surveys to architecture student. The measurement of temperature reading was taken at three different locations which is located in front, middle and back of the studio. Each locations has been labeled as L1, L2, L3 as in Figure 1. The temperature reading was recorded for every hours within 10 hours for 2 days starting at 8.00 am till 6.00 pm by using the equipment named LM-8100 (for physical measurement) and FLUKE Thermal Imager (for infra red image). Figure 2 shows the elevation of the studio.

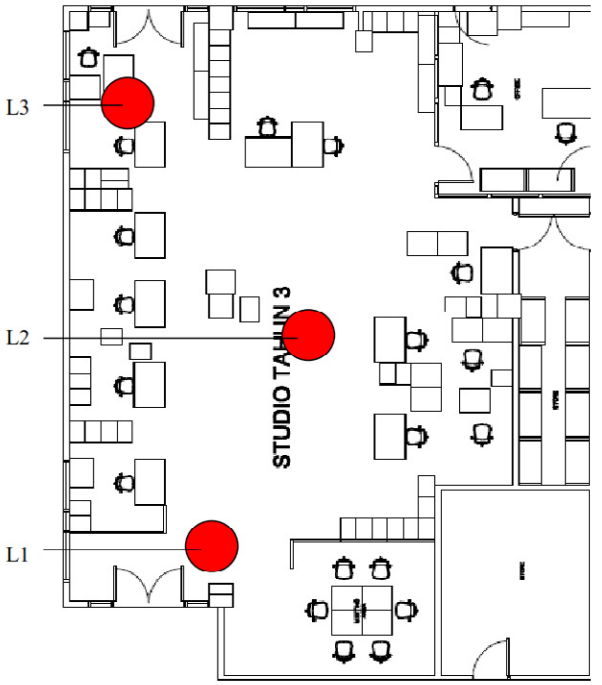

Figure 1. Location of data collection as labeled L1, L2 and L3

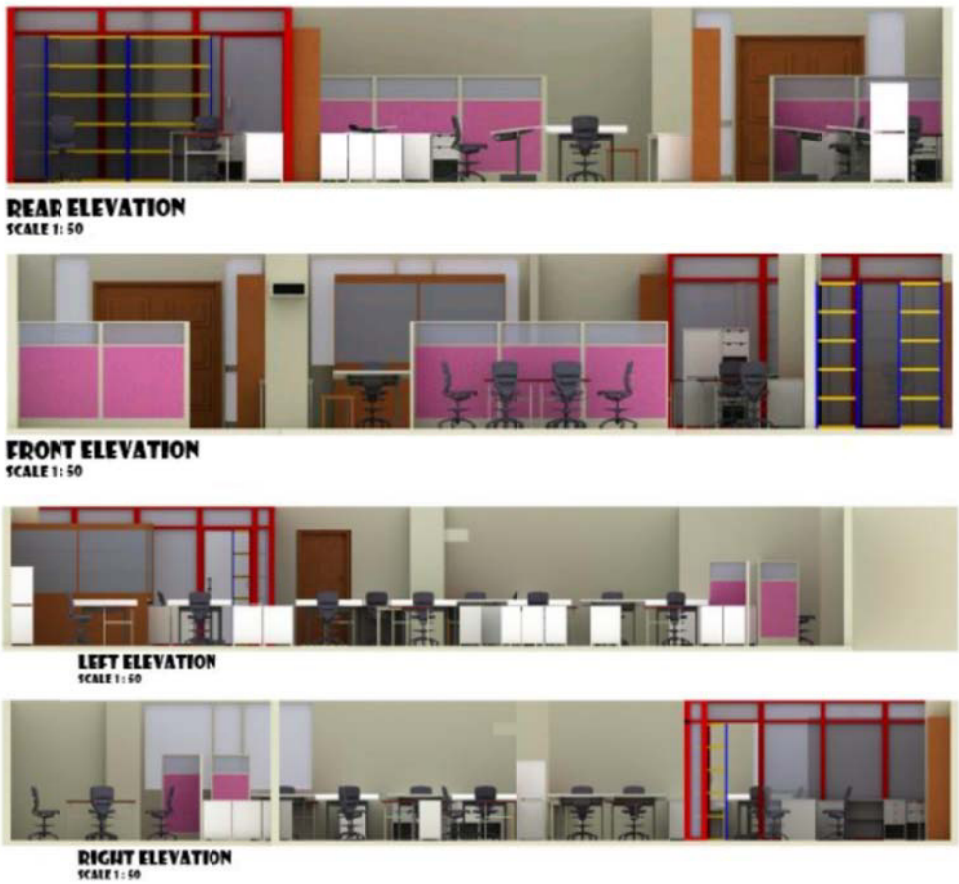

Figure 2. Elevation of the studio

The questionnaire survey distributed to all 12 year 3 architecture's student as to identify the existing scenario in the architecture studio related to the temperature comfort and humidity and also the importance of temperature comfort in student's perspective. The result of the temperature measurement and questionnaire survey are discussed and presented. According to Fraser and Walberg (1982) and Rivera and Ganaden (2001), there are advantages of conducting research through the questionnaire method to obtain student's perceptions of learning environment compared to observation. The main reason is the use of questionnaires can be done directly and more economical compared with the observations technique in the studio space. The use of student perception involves a combination of the views expressed by all students in the studio, while the observation technique only looks at the view from one of the bystanders (Che Nidzam Che Ahmad et al. 2010).

Current comfort standards are intended to optimize the thermal acceptability of indoor environments. Therefore, in setting a good practice for IEQ, this study is based on Malaysian Standard (MS) 1525: 2007 "Code of Practice on Energy Efficiency and use of Renewable Energy for Non-Residential Building" as follows:

Internal space environment:

a. The proposed design of the dry ball temperature (dry bulb): 23 ^{o}C -26 ^{o}C

b. Minimum temperature of dry ball (dry bulb): 22 ^{o}C

c. Proposed Relative Humidity (RH): 55-70%, and proposed air movement: 0.15-0.5m/s

3. Results and Discussion

3.1. Temperature analysis

Figure 3 shows temperature analysis of the indoor environment of the studio year 3 on day 1. On the day 1, the indoor temperature show the lowest reading at 8 am located on L2, and the highest reading at 1 pm also located on L2 (in the middle of the studio). From the day 1 temperature analysis found that the temperature reading from 8 am to 6 pm was in range of 26.5 ^{o}C to 28 ^{o}C.

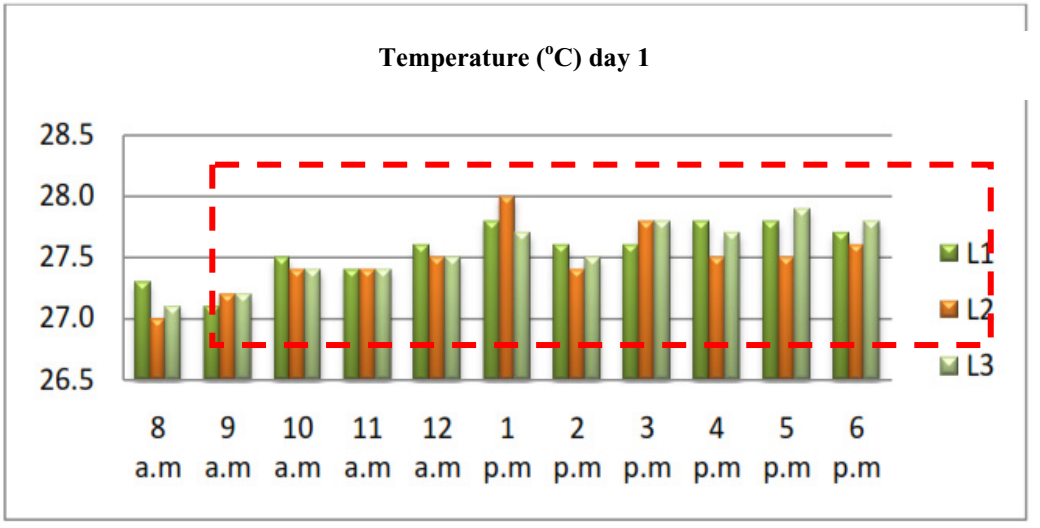

Figure 3. Temperature readings at year 3 studio on day 1

Figure 4 presents the temperature analysis of the indoor environment of the year 3 studio on day 2. The lowest temperature reading is at 9 am located at L2 and 11 am located at L3 where the temperature reading is 27.9 ^{o}C, while the highest temperature was at 1 am located at L1 with the temperature reading at 28.7 ^{o}C and the range of temperature reading from 8 am to 6 pm is between 27.4 ^{o}C to 28.7 ^{o}C. The temperature range on day 2 was higher than day 1.

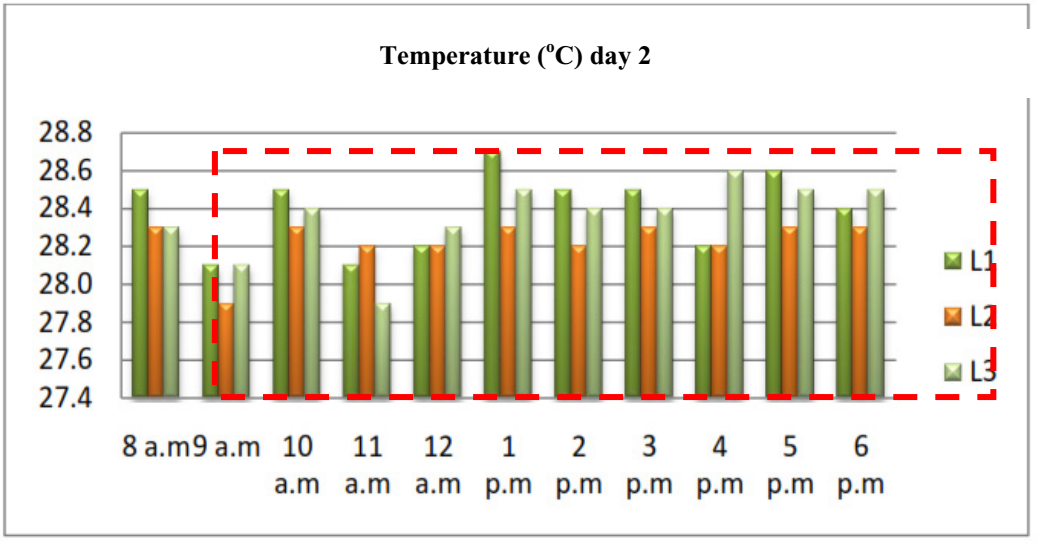

Figure 4. Temperature reading at year 3 studio on day 2

This findings shows that temperature range in year 3 studio was not in accordance with the MS 1525:2007, namely for internal space environment which should have a dry bulb temperature in a range of 23 ^{o}C -26 ^{o}C. This means that the indoor environment for UKM architecture year 3 studio was not following suggested temperature setting for all 3 locations in the studio. As for graphic image, it is captured using FLUKE Thermal Imager as in Figure 5.

Figure 5. Thermal Image of year 3 studio

3.2. Questionnaire survey

The survey was done to all architecture students occupying the studio and was carried out to 12 students. In the survey forms, there are two parameters to determine thermal comfort for studio environment; namely thermal comfort and humidity. The scores are calculated based on students' response on the importance of thermal comfort and existing scenario. Figure 6 shows both parameters namely thermal comfort and humidity is perceived as important to the student, with above 70% of important level recorded. For existing scenario, the students satisfaction level is accepted, with the score of 50% and above for both parameters.

Figure 6. Thermal comfort and humidity satisfaction scores for all year 3 architecture student

3.3. Matrix of the indoor environmental quality for UKM architecture studio

From the analysis, there are 2 parameters (data input), namely the measurement and questionnaire survey. This source of data is combined to develop the matrix that can be easily used to conclude the study. The matrix is presented in 3 situations, namely "Good", "Need Improvement" and "Poor", shown in figure 7. The "Good" matrix is achieved when both parameters are in accordance with the MS 1525:2007 and the survey findings is at above 50% respectively; and vice versa for "Poor" matrix. For "Need Improvement" matrix, either one of the parameter is either good or poor.

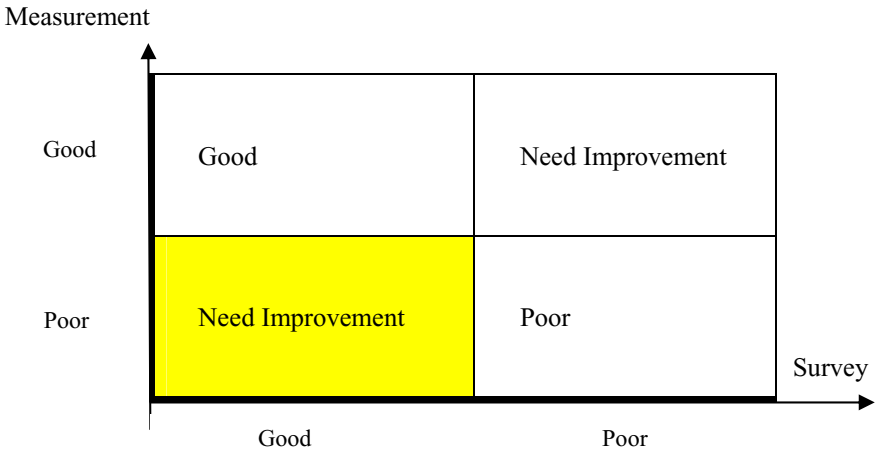

Figure 7. Matrix of the indoor environment quality for UKM architecture studio

According to this matrix, Figure 7 is the overall result shows that the IEQ for UKM architecture studio is need improvement, where the temperature measurement of internal studio environment was not up to standard (poor) and the result of the questionnaire survey for existing scenario shows that at least 50% of students are satisfied with the temperature comfort and humidity (good). This matrix therefore concludes this finding.

Interestingly, the students are satisfied with the temperature setting for the internal studio, whens the measurement itself shows contradicting idea (with temperature recorded above 26 ^{o}C). This might be due to different student has different needs in terms of temperature setting. Even though the studio is fully air conditioned, the informal observation carried out during the survey is found that a few set of table fans are located near the student's work station that suggested the use of fan is sometimes needed to achieve their perceived comfort level. This somehow justifies why students perceived they could stay in the studio, even the temperature measurement suggest they should not. The temperature can be considered "hot" (with 26 ^{o}C and above), but the students can take it as normal. This is actually acceptable for the short-term period, but can cause negative effects if it is prolonged in leading that can lead to sick building syndrome.

4. Conclusions

IEQ plays an important role in ensuring a conducive studio-based learning environment for architecture students. The finding shows that the temperature setting of UKM year 3 architecture studio is not within the range of MS 1525:2007. The questionnaire result found that most of the architecture student agreed that temperature comfort and humidity is most important for internal studio environment. The matrix of IEQ for UKM year 3 architecture studio indicates that this particular studio "Need Improvement". The improvement needed is on the temperature setting. Although the students perceived the existing temperature as normal and this do not hinder them to stay longer inside their studio, but this situation somehow is only good to the learning environment for the short term, but in the long run might give negative health effect to the students. This finding can be used by lecturers or administrators to take appropriate measures to streamline the efforts towards providing conducive learning environment for architecture studio.

Acknowledgements

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